What is Claimed is:

1. A rolling element

which is made from a steel material containing at least 0.45 to 1.5 wt% C and one or more alloy elements selected from 0.1 to 0.5 wt% V and 0.3 to 1.5 wt% Cr, and

which has a rolling contact surface layer having a structure tempered at low temperature in which 2 to 18% by volume cementite disperses in a martensite parent phase formed by induction heating and cooling and containing 0.25 to 0.8 wt% carbon solid-dissolving therein.

2. The rolling element according to claim 1, wherein the average Cr concentration of the cementite dispersing in a quench hardened layer is adjusted to 2.5 to 10 wt%.

3. The rolling element according to claim 2, wherein the cementite dispersing in the quench hardened layer is substantially granulated and the average particle diameter of the cementite is 0.1 to 1.5 μm.

4. The rolling element according to claim 2, wherein the cementite dispersing in the quench hardened layer has at least a portion of a pearlitic structure.

5. The rolling element according to claim 2, wherein the quench hardened layer contains 10 to 60% by volume retained austenite.

6. The rolling element according to claim 1, made from a steel material having substantially the same composition as that of the rolling contact surface layer, the rolling contact surface layer being subjected to induction hardening so as to have a martensitic structure in which prior austenite grains are fined to a size equal to or higher than

ASTM grain size No. 10.

7. The rolling element according to claim 1, which is made from a steel material containing 0.5 to 3.0 wt% Si, 0.25 to 1.5 wt% Al, or 0.5 to 3.0 wt% (Si + Al); and further containing one or more alloy elements selected from Mn, Ni, Cr, Mo, Cu, W, B, and Ca, unavoidable impurity elements such as P, S, N and O, and balance essentially consisting of Fe.

8. The rolling element according to claim 7, wherein 0.3 to 1.5 wt% Ni is added to the steel material containing 0.25 wt% or more Al.

9. The rolling element according to claim 1,

which is made from a steel material containing at least 0.05 to 0.2 wt% one or more alloy elements selected from Ti, Zr, Nb, Ta and Hf and one or more compounds selected from the carbides, nitrides and carbonitrides of said alloy elements, said compounds having an average particle diameter of 0.1 to 5 μm and dispersing within the steel material,

which has a rolling contact surface layer containing 0.5 to 1.5 wt% C, the rolling contact surface layer having a martensite parent phase tempered at low temperature after quenching.

10. The rolling element according to any one of claims 1 to 9, which is used as a gear and wherein the relationship between the DI value indicating the hardenability of a martensite phase and gear module M is described by DI $\leqq 0.12 \times M + 0.2$, said martensite phase being previously a ferrite phase and containing 0.25 to 0.8 wt% carbon.

11. The rolling element according to claim 10, wherein said steel material contains at least 0.53 to 1.5 wt% C, 0.3 to 1.5 wt% Cr

and/or 0.1to 0.3 wt% V, 0.2 to 0.5 wt% Mn, 0.5 to 2 wt% Si, 0.2 wt% or less Mo, and 0.2 wt% or less W.

12. The rolling element according to claim 10, wherein said steel material contains at least 1.2 to 1.5 wt% C, 0.6 to 1.5 wt% Cr and/or 0.1to 0.3 wt% V, 0.2 to 0.5 wt% Mn, 0.5 to 2 wt% Si, 0.2 wt% or less Mo, and 0.2 wt% or less W.

13. The rolling element according to claim 10, wherein a compressive residual stress of 50 kgf/mm^2 or more remains at least on the surfaces of the roots of teeth.

14. The rolling element according to claim 13, wherein a compressive residual stress of 50 kgf/mm^2 or more is allowed to remain on tooth profile surface layers each composed of a tooth top, a pitch circle position, a tooth root and a tooth bottom by mechanical processing means such as shot peening for generating said compressive residual stress.

15. The rolling element according to claim 14, wherein a compressive residual stress of 50 kgf/mm^2 or more is allowed to remain on surface layers at the ends of the teeth by mechanical processing means such as shot peening for generating said compressive residual stress.

16. A rolling element

which is made from a steel material containing at least 0.1 to 0.45 wt% C and one or more alloy elements selected from 0.1 to 0.5 wt% V and 0.3 to 1.5 wt% Cr,

wherein the carbon concentration of a rolling contact surface is adjusted to 0.6 to 1.5 wt% and the depth of an area having a carbon

concentration of 0.45 wt% is adjusted to 0.4 mm or more from the surface by carburizing or carbonitriding, and

wherein the rolling contact surface has a structure tempered at low temperature in which 2 to 18% by volume cementite disperses in a martensite parent phase formed by induction hardening and containing 0.25 to 0.8 wt% carbon solid-dissolving therein.

17. A method of producing a rolling element from a steel material containing at least 0.45 to 1.5 wt% C and one or more alloy elements selected from 0.1 to 0.5 wt% V and 0.3 to 1.5 wt% Cr,

the method comprising:

a Cr incrassating treatment step for heating the steel material such that the average Cr concentration of cementite contained in the steel material becomes 2.5 to 10 wt%;

an induction hardening treatment step for induction heating the steel material from a temperature equal to or lower than the A1 temperature to a quenching temperature of 900 to 1100℃ within 10 seconds, followed by rapid cooling; and

a tempering treatment step for heating the steel material to 100 to 300℃.

18. The method of producing a rolling element according to claim 17, wherein the Cr incrassating treatment step is comprised of a first heating treatment and/or a second heating treatment, the heating temperature of the first heating treatment being the A1 temperature to 900℃ in the two phase (cementite + austenite) region, the heating temperature of the second heating treatment being 300℃ to the A1 temperature in the two phase (cementite + ferrite) region.

19. The method of producing a rolling element according to claim 17, wherein the steel material contains at least 0.8 to 1.5 wt% C,

which further has a spheroidizing treatment step in which granular cementite having an average particle diameter of 0.1 to 1.5 μm is dispersed by slow cooling or cooling to a temperature equal to or lower than the A1 temperature and then reheating to a temperature equal to or higher than the A1 temperature, after the first heating treatment of the Cr incrassating treatment step in which the cementite is incrassated at a heating temperature of the A1 temperature to 900℃ in the two phase (cementite + austenite) region.

20. The method of producing a rolling element according to claim 18, which further has a preheating treatment step in which the steel material is preheated at 300℃ to the A1 temperature before the induction hardening treatment step, and

wherein the speed of heating from a temperature equal to or lower than the A1 temperature to a quenching temperature of 900 to 1100℃ in the induction hardening treatment step is set to 150℃/sec or more.

21. A method of producing a rolling element from a steel material containing at least 0.1 to 0.45 wt% C and one or more alloy elements selected from 0.1 to 0.5 wt% V and 0.3 to 1.5 wt% Cr,

the method comprising:

a carburizing or carbonitriding treatment step for adjusting the carbon concentration of a rolling contact surface to 0.6 to 1.5 wt% and adjusting the depth of an area having a carbon concentration of 0.45

wt% from the surface to 0.4 mm or more;

a Cr incrassating treatment step for heating the steel material such that the average Cr concentration of cementite contained in a carburized or carbonitrided layer becomes 2.5 to 10 wt% and/or a granulating treatment step for dispersing granular cementite having an average particle diameter of 0.1 to 1.5 μm by slow cooling or cooling to a temperature equal to or lower than the A1 temperature and then reheating to a temperature equal to or higher than the A1 temperature;

an induction hardening treatment step for induction heating the steel material from a temperature equal to or lower than the A1 temperature to a quenching temperature of 900 to 1100℃ within 10 seconds, followed by rapid cooling; and

a tempering treatment step for heating the steel material to 100 to 300℃.

22. The method of producing a rolling element according to any one of claims 17 to 21, further having a mechanical treatment step in which a compressive residual stress of 50 kgf/mm^2 or more is generated, by a treatment such as shot peening, in a part or the whole of the surface layer of the rolling element after the induction hardening treatment step.